**Background:** Proximal migration of pancreatic stents (PMPS) is an infrequent event but its management can be technically challenging and there are no standard retrieval methods.

The objective of this study was to determine the results of an endoscopic stent retrieval algorithm in terms of feasibility and efficacy of the endoscopic procedure.

**Methods:** During the period from Jan 2008 to Dec 2009, 15 patients (8 women and 7 men with a mean age of 51.9 years) with PMPS were included in this study. Stent retrieval was approached initially with balloon extraction followed by rat-tooth forceps and basket. A rescue approach such as using a stent retriever was attempted when other approaches failed.

**Results:** All the PMPS were retrieved successfully within one ERCP session. Balloon extraction was successful in 9 (60%) patients. In the 6 failed cases of balloon extraction, wire-guided rat-tooth forceps grasp was successful in 4 patients, stone extraction basket grasp was successful in 1 patient who failed forceps grasp. One stent was finally rescued with a stent retriever when balloon extraction, forceps and basket grasp all failed. In patients with successful balloon extraction, 44.4% of the patients (4/9) developed post-ERCP hyperamylasemia but none of them developed post-procedure pancreatitis.

**Conclusion:** With this algorithm, PMPS was successfully retrieved in all of the cases. Most PMPS retrieval can be safely achieved with commonly used approaches. Those less used approaches can be used as a rescue method.

**Key words:** Algorithm, endoscopic retrieval, pancreatic stents

### II. Patients and methods

**A. Patients**

Between January 2008 and December 2009, there were 191 patients who underwent endoscopic pancreatic stenting for various pancreaticobiliary disorders at our tertiary referral center for biliary and pancreatic disorders. In total, 15 patients with PMPS were consecutively enrolled including 8 women and 7 men with a mean age of 51.9 years (range 15-83 years). Eight cases occurred in our center with a migration rate of 4.2% (8/191). Seven patients with migrated stents came from outside institutions. Indications for stenting included chronic pancreatitis (11), pancreas divisum (1), pancreatic Sphincter of Oddi dysfunction (SOD) (1), sphincterotomy (1), and prevention of post-ERCP pancreatitis (3). The mean interval between placement of the stent and detection of migration was 150 days (range 58-354 days). Among the 11 patients with chronic pancreatitis, nine had proximal PD stricture, two had incomplete pancreas divisum, and 9 patients had a dilated PD (range from 4 to 7 mm). Thirteen patients underwent main PD stenting only, one had dorsal PD stenting only and one had both main and dorsal PD stenting. Twelve patients (80%) were asymptomatic when the stent migration was identified but 3 patients (25%) presented with hyperamylasemia. Three patients (25%)
presented with pancreatitis with abdominal pain and hyperamylasemia more than three times the upper limits of normal. Diameters of stents included 5F (6) and 7F (9). Lengths of stents included 5cm (5), 7cm (6), and 9cm (4). Fourteen stents were straight stents with flaps at both ends. One stent was single pig tail stent. Fourteen stents migrated into the main PD and 1 into the dorsal PD. This prospective study was approved by our institutional review board, and all patients provided written informed consent.

B. Retrieval algorithm

Patients were sedated with meperidine, midazolam (or diazepam) with appropriate cardiorespiratory monitoring. Stent retrieval was performed by an experienced endoscopist (Dr. Biao Gong) who performs more than 1,000 ERCP procedures annually for pancreaticobiliary disease. The existent strictures in the proximal PD were dilated with dilation balloon or bougie before stent retrieval. Endoscopic sphincterotomy or dilation was performed on the intact minor papilla if retrieval of PMPS from the dorsal PD was determined.

All the PMPS were retrieved initially with balloon extraction by inflating an over-the-wire stone extraction balloon (Wilson Cook) alongside or above the migrated stent and dragging the stent distally. If balloon extraction failed after five repeated attempts, another accessory was used (Figure 1).

In cases without PD dilation, a rat-tooth forceps (Olympus FG-44NR-1, Japan) was introduced into the PD by grasping the guide wire to the distal end or the shaft of the stents. Direct grasping of the stent was then conducted under fluoroscopy. If this approach failed after five repeated attempts, a rescue approach was attempted. In cases with PD dilation, retrieval with a rat-tooth forceps was also tried first. If it failed after five repeated attempts, a wire guided basket (Endoflex, Germany) was used to grasp the stent and a rescue approach was considered after five repeated failed attempts.

Three techniques were available in our center as a rescue approach: (1) retrieval with a stent retriever (7F, Wilson-Cook) after cannulating the stent lumen with a guide wire, (2) stent extraction under the direct visualization of pancreatoscopy, (3) retrieval with interventional cardiology angioplasty balloon.

Successful retrieval was defined as complete removal of the stent from the pancreatic duct, despite number of attempts. Patients were followed prospectively for clinical outcomes and complications after stent retrieval. This study was approved by the institutional review board of the Shanghai Jiao Tong University School of Medicine.

III. Results

Stents were successfully retrieved in all fifteen patients (100%) (Table1). The success rate for balloon extraction was 60% (9/15). In one patient, the proximal end of a single pig tail stent was wedged into a side-branch of the main PD. An inflated balloon was put alongside the stent and pushed the stent outside of the side-branch before retrieval of the stent (Figure 2). In another patient with incomplete pancreas divisum, the proximal end of the stent wedged into the dorsal PD through the communication duct. The initial attempt to push it back to the main PD with an inflated balloon failed. As a result, a sphincterotomy was performed on the minor papilla followed by pulling the stent with an inflated balloon in the main PD toward the minor papilla. Finally, the proximal end of stent was pulled outside of the minor papilla.

Four patients (4/6) had the stent successfully retrieved with a rat-tooth forceps after balloon extraction failed. In one of the patients with incomplete pancreas divisum, the proximal end of the stent wedged into the communicating duct between the main and dorsal duct. An inflated balloon failed to push the stent out of the communicating duct, a rat-tooth forceps was subsequently used to grasp the stent shaft and finally retrieved it out of the main PD. The use of balloon and rat-tooth forceps accounted for 86.7% (13 of 15) of the successfully retrieved PMPS in our series. Both balloon extraction and rat-tooth forceps grasping were not successful in one patient with significant PD dilation. The stent was finally retrieved successfully with a wire-guided stone extraction basket. Balloon extraction, forceps grasp and basket extraction all failed in one patient, where the PMPS was finally successfully retrieved with a 7F stent retriever.

Naso-pancreatic tube placement was performed in 12 patients after stent retrieval. Two patients underwent stent replacement with 7F (7cm) strait pancreatic stent. One patient with pancreas divisum underwent stent replacement with a 7F (12cm) single pigtail stent.

In patients with successful balloon extraction, four patients (4/9, 44.4%) developed post-ERCP hyperamylasemia but none of them developed pancreatitis. One patient developed acute edematous pancreatitis after stent retrieval with a rat-tooth forceps after balloon extraction failed. He underwent conservative treatment and the recovery process was uneventful. After stent retrieval, abdominal pain and hyperamylasemia all disappeared in all 3 patients with prior pancreatitis and serum amylase returned to normal in 2 of the 3 asymptomatic patients with prior hyperamylasemia. Three of the rest 9 asymptomatic patients developed hyperamylasemia after stent retrieval but remained asymptomatic.

Discussion

Proximal migration of pancreatic stents is one of the late complications of pancreatic stenting and has gained awareness now for some time among endoscopists due to
its potential serious consequences. In this study, the proximal migration rate of the PD stents in our center during the study period was 4.2% with the majority (78.6%) of patients asymptomatic upon presentation. Retrieval of PMPS has previously been reported in some studies with a success rate of more than 75% [4, 5]. To retrieve the PMPS, multiple attempts with various accessories may be tried but there is no standard retrieval method and its rationale in selection of accessories hasn’t been documented very well. It was therefore proposed to perform an intention-to-treat analysis with a prospective design including the different endoscopic retrieval approaches to determine whether the use of this algorithm might bring a high success rate in endoscopic retrieval of PMPS. In the present study, all PMPS were successfully retrieved (100%) and all the patients required only one session of ERCP. Dilatation of a downstream PD stenosis with pancreatic sphincterotomy or dilation was performed prior to retrieval, which contributed to the success. Only one patient developed acute edematous pancreatitis after stent retrieval. Naso-pancreatic drainage or replacement of a pancreatic stent may help to reduce the risk of pancreatitis associated with repeated stent extraction.

Balloon extraction was the first method used to retrieve PMPS in this series. First, balloon extraction has been reported to be the most commonly used PD stent retrieval approach [4]. Second, we believe an inflated balloon within the relatively small PD could provide enough shearing strength against the stent when dragging it distally. Third, other accessories (basket, snare, and grasping forceps) may cause more mechanical injury to the PD. In this series, the majority of PMPS can be successfully retrieved with balloon extraction (60%, 9 of 15). In addition, there was zero occurrence of acute pancreatitis after a successful balloon extraction in this study. This supports Price et al’s recommendation that stent retrieval should be initially approached with balloon extraction [4]. However, hyperamylasemia occurred in 44.4% of those who underwent balloon extraction only. The potential damage of balloon extraction on the PD still needs to be evaluated by future larger scale studies.

Stents wedged in the dorsal PD or embedded into a side-branch of the main duct are a technical challenge for stent retrieval [9-10]. Some patients need more than one attempt or finally require surgery to remove the stent [5]. In our experience, the embedded stent can be pushed outside of the side-branch duct or dorsal duct with an inflated balloon or grasped with a forceps. When the proximal end of the stent migrated into the dorsal PD through the communication duct in incomplete pancreas divisum, the stent can be extracted through the minor papilla with balloon extraction after minor papilla sphincterotomy or dilation. If failed, the stent shaft can be grasped with a rat-tooth forceps in the main PD and retrieved. However, we feel more comfortable using this technique when there is significant PD dilation considering that the stent will be in a curled, doubled position. We successfully removed three stents by using these methods. This may provide a useful clue in the selection of retrieving devices for similar conditions. If balloon and grasping forceps failed, direct extraction with pancreatoscopy may facilitate removal of the embedded stents.

The choice of other accessories in this series when the initial balloon extraction failed was determined by the condition of PD. We chose rat-tooth forceps partially due to our experience in using this accessory. In cases without PD dilation, especially if it is difficult to place the guide-wire or catheter alongside the stent, over-the-wire snare or basket will be difficult to manipulate due to the limited space. In this circumstance, we prefer to cannulate the stent lumen with a guide-wire, and then the wire was grasped by a rat-tooth forceps which can be advanced to the proximal end of the stent to grasp it. We successfully removed a PMPS using this method after balloon sweep failed. However, this method can be difficult or impossible to achieve when facing an occluded stent. In cases with significant PD dilation, grasp forceps, snare or basket can all be tried but rat-tooth forceps seems difficult to grasp the stent sometimes due to the two-dimensional view under the fluoroscopy. Direct forceps grasp failed in two cases (2/6) in this series.

The major limitation of this study is a small study sample. It is also difficult to compare the effectiveness and complication rates among different retrieval approaches. Other retrieval methods such as trapping the distal flap with the sphincterotomy cautery wire, insertion of an inflated dilating balloon above or within the stent lumen, intraductal endoscopy or using interventional cardiology accessories all may play a role in solving difficult cases based on the performer’s experience and availability of equipment. The effectiveness of these techniques was left to be discussed and debated in future studies.

In conclusion, based on our algorithm in this study, PMPS retrieval was successfully achieved in all patients. Balloon extraction appeared safe and can be used as an initial approach for retrieval of PMPS with a relatively high success rate. Most PMPS can be retrieved with commonly used accessories. A variety of techniques with other accessories played a rescue role when those commonly used approaches failed. Large-scale, randomised studies are needed to compare the effectiveness and complications among different retrieval techniques.

Acknowledgements

We thank Dr. Bill Tu of the ParkwayHealth Medical Center (North Asia), for his review of this manuscript.

Disclosures

Drs. Biao Gong, Bo Sun, Li-xiao Hao, and Li-ke Bie
References


have no conflicts of interest or financial ties to disclose.
Table 1. Retrieval of proximally migrated PD stents

<table>
<thead>
<tr>
<th>PD stents</th>
<th>15</th>
</tr>
</thead>
<tbody>
<tr>
<td>No. migrated</td>
<td>15</td>
</tr>
<tr>
<td>No. retrieved</td>
<td>15</td>
</tr>
<tr>
<td>Successful technique:</td>
<td></td>
</tr>
<tr>
<td>Balloon extraction</td>
<td>9</td>
</tr>
<tr>
<td>rat-tooth forceps</td>
<td>4</td>
</tr>
<tr>
<td>Basket</td>
<td>1</td>
</tr>
<tr>
<td>Stent retriever</td>
<td>1</td>
</tr>
<tr>
<td>Balloon extraction failed</td>
<td>6</td>
</tr>
<tr>
<td>No. of retrieved from main papilla</td>
<td>13</td>
</tr>
<tr>
<td>No. of retrieved from minor papilla</td>
<td>2</td>
</tr>
<tr>
<td>Facilitate retrieval technique:</td>
<td></td>
</tr>
<tr>
<td>No. of sphincterotomy</td>
<td>2</td>
</tr>
<tr>
<td>No. of balloon dilation of PD stricture</td>
<td>4</td>
</tr>
<tr>
<td>No. of balloon dilation of minor papilla</td>
<td>1</td>
</tr>
</tbody>
</table>

Figure 1. Endoscopic retrieval algorithm for proximally migrated pancreatic stents

**Proximally migrated pancreatic stent**

Dilation of an existed PD stricture, EST if needed

Balloon extraction

- No PD dilation
  - If failed
  - Extraction with rat-tooth forceps
    - If failed
    - Extraction with basket or snare
    - If failed
    - Rescue approach with stent retriever, interventional cardiology angioplasty balloon or pancreatoscopy

PD: Pancreatic duct, EST: Endoscopic sphincterotomy
Figure 2A. The proximal end of a single-pigtail stent was wedged into a side-branch pancreatic duct.

Figure 2B. The wedged stent was pushed outside of the side branch with an inflated balloon.